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(54) **Improved surface tack-free photosensitive resin composition and a method using same.**

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Description

This invention relates to a photosensitive resin composition, and more particularly to a photosensitive resin composition which is improved with respect to surface tack-free characteristic after curing by exposure to actinic radiation and which can provide pattern structures improved with respect to surface tack-free characteristic. This invention also relates to a method of preparing a surface tack-free, photocured pattern structure using the photosensitive resin composition which enables pattern structures improved with respect to surface tack-free characteristic to be obtained in a shortened period of time.

The term "photocured pattern structure" used herein is intended to embrace a photorelief image and photoresist which have convex and concave portions and a depth of about 0.1 mm to 10 mm. The photocured pattern structure may be used as a letterpress, molding matrix, decorative material having convex and concave portions.

The process for preparing relief images essentially comprises an exposure step and a development step. In general, however, a post-exposure step is also included in order to improve the mechanical strength of the relief images and to reduce the surface tack of the relief images. Further, when the development is performed using a liquid developer, a drying step is involved.

Generally, with respect to the case where a photocurable resin layer is exposed to actinic radiation to form photocured relief images, the relief images prepared by the above-mentioned steps encounter difficulties in practical use as described later because the surface tack of the photocured relief images is still high. The surface tack of the photocured relief images is caused as follows. When a photocurable resin layer is irradiated with actinic radiation through an image-bearing transparency, the photocuring of the photocurable resin occurs, but the photocuring of surface portions of the photocurable resin layer is inhibited by oxygen, causing surface tack of top portions of the photocured relief images. In the case of certain kinds of photocurable resins, the surface tack of the photocured relief images obtained therefrom is considerably high. Further, since the actinic radiation is decreased with respect to intensity in the course of its thicknesswise passing the photocurable resin layer, the photocuring of portions of the resin corresponding to the side and bottom portions of the convexes and concaves of the relief images is insufficient, leading to high surface tack of the relief images. Especially when the development is performed using a developer containing water at a concentration of 50% or more, since the side and bottom portions which are insufficient in photocuring are difficult to dissolve in water, the side and bottom portions are apt to be tacky, leading to high surface tack of the relief images. In recent years, from the standpoints of waste liquid treatment and the improvement of working environment, the development is mainly carried out using an aqueous surfactant solution, aqueous alkaline solution or water. Therefore, the surface tack of the photocured relief images is not improved and is still high.

Due to the surface tack of the photocured relief images, there are caused various problems. For example, in handling the photocured relief images they adhere to the hands of workers and workability is decreased due to the adhesion of the photocured relief images to each other. Further, dusts adhere to the photocured relief images, causing deterioration of the product quality. When the photocured relief images are used as printing plates, in addition to the above drawbacks, dusts such as paper dusts adhere to the printing areas (top portions of convexes of the relief images) and non-printing areas (side portions of the convexes and bottom portions of concaves of the relief images) during printing, making the printed articles dirty. This causes a need to stop the printing operation and to clean the printing plates by wiping, lowering the operation efficiency. Moreover, when a material to be printed is paper, peeling of paper is caused by the surface tack of the printing plates, reducing the yield of prints which is defined by the percentage of printed articles of good quality which can be sold as a product among the total printed articles.

To eliminate or diminish these disadvantages there have been proposed and adopted methods in which the surface of relief images is improved by chemical treatment or physical treatment, such as (i) a method in which the relief images are treated with an oxidant, reducing agent, (ii) a method in which after preparing a relief image, a coating material is applied onto the surface of the relief image and (iii) a method in which the post-exposure of the relief images to actinic radiation is conducted in an inert gas or while dipping the relief images in a liquid so that oxygen does not inhibit the photocuring. As one example of the above method (i), there is known a method in which the inhibition of photocuring due to oxygen is eliminated using a reducing material in the step of post-exposure (Japanese Patent Application Publications Nos. 50-38964 and 50-31487 and Japanese Patent Application Laid-Open Specification No. 58-97043). However, the above-mentioned methods are still defective because the surface tack-removing effect is insufficient. Further, with respect to the above method (ii), although a sufficient surface tack-removing effect is obtained, a troublesome step for application of a coating material is required and further a prolonged effect is not sufficiently ensured. The method (iii) is disclosed, for example, in Japanese Patent Application Laid-Open Specification No. 58-97043. However, this method is also still insufficient in removing surface tack. To meet further requirements for such photo-cured resin printing plates, a number of improved compositions have been proposed. As an example, US-A-4,139,436 may be mentioned, wherein an improved liquid ethylenically unsaturated polyether urethane composition is described which is characterised by the ability to produce printing plates having better half-tone characteristics. Their composition described therein contains 0.5 to 15% of dialkylaminoalkylacrylate or methacrylate, the alkyl radical of which contains 1 to 10 carbon atoms. As described therein, such a composition is capable of

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producing printing plates having fine half-tone dots. Attention is then drawn to the fact that the ethylenically unsaturated polyurethane compound disclosed in said document has relatively low molecular weights per double bond in the polymer (in the region of 1,850 per double bond which is much less than 5,000 per double bond) and, hence, cannot provide printing plates which are sufficiently flexible and elongated to be used for flexography.

In "Chemical Abstracts, Vol. 87, Ref. No. 118959U" tack-free adhesive compositions containing specific fatty acids are disclosed. These compositions are, however, not photo-polymerisable, and are used as adhesives.

Taking into consideration the above-mentioned problems involved in the conventional methods of removing the surface tack of a photocured resin, the present inventors have made extensive and intensive investigations with a view to developing a new photosensitive material and a new method, whereby a photocured pattern structure free from a surface tack problem can be advantageously obtained. As a result, the present inventors have found (1) that by incorporating into a photocurable resin composition at least one compound represented by the formula (I) which will be mentioned later, there can be obtained a photosensitive resin composition which is improved with respect to surface tack-free characteristic after curing by exposure to actinic radiation and (2) that when a photosensitive resin composition containing at least one compound represented by the formula (I) which will be mentioned later is used to prepare a photocured pattern structure and the photocured pattern structure is subjected to post-exposure to actinic radiation while being immersed in an aqueous solution containing an alkali metal salt or alkaline earth metal salt of sulfurous acid, there can be stably obtained a photocured pattern structure which is free from surface tack even immediately after the preparation thereof. Based on the findings, the present invention has been completed.

Accordingly, it is an object of the present invention to provide a photosensitive resin composition which is improved with respect to surface tack-free characteristic after curing by exposure to actinic radiation.

It is another object of the present invention to provide a method of preparing a surface tack-free photocured pattern structure using the photosensitive resin composition, which enables pattern structures improved with respect to surface tack-free characteristic to be obtained in a shortened period of time.

The foregoing and other objects, features and advantages of the present invention will be apparent to those skilled in the art from the following detailed description taken in connection with the accompanying drawing which is a schematic diagram of an apparatus for determining the surface tack of a photocured pattern structure.

In one aspect of the present invention, there is provided a photosensitive resin composition to be used for preparing a printing plate for flexography which is improved with respect to surface-tack free characteristic after curing by exposure to actinic radiation, said photosensitive resin composition comprising

- (a) an ethylenically unsaturated prepolymer having a number average molecular weight of 5000 or more per double bond;
- (b) an ethylenically unsaturated monomer; and
- (c) a photoinitiator, and being characterised in that it further comprises
- (d) at least one compound represented by the general formula (I)



wherein R^1 stands for a monovalent hydrocarbon residue represented by C_nH_{2n+1} or C_nH_{2n-1} in which n is an integer of from 11 to 21; and X stands for $-COOH$, $-CONH_2$ or $-CH_2OR^2$ in which R^2 stands for H or $-CO-R^3-S-R^3-COOCH_2-R^4$ in which R^3 is a divalent hydrocarbon residue having 1 to 6 carbon atoms and R^4 has the same meaning as defined with respect to R^1 .

The photocurable resin composition to be used in the present invention is defined as that which is capable of being insolubilized upon exposure to actinic radiation.

As the photocurable resin composition to be used in the present invention, there may be mentioned various kinds of compositions. As examples of such composition there may be mentioned a composition comprising an ethylenically unsaturated material and photoinitiator; a composition comprising a binder polymer, ethylenically unsaturated material and photoinitiator; a composition comprising a polyene, polythiol and photoinitiator; and

In addition to the above compositions, a composition comprising a polymer having at least one cinnamoyl group and a photoinitiator may also be used as the photocurable resin composition. This composition is capable of absorbing ultraviolet rays (actinic radiation) very well. Therefore, when this composition is singly used as the photocurable resin composition, the actinic radiation is extremely decreased with respect to intensity in the course of its thickness-wise passing the layer of a photosensitive resin composition containing this composition. Hence, if the thickness of such a layer is too thick, the photocuring of the layer is apt to be insufficient. From the above viewpoint, a photosensitive resin composition containing, as the photocurable resin composition, a composition comprising a polymer having at least one cinnamoyl group and a photoinitiator may preferably be used for preparing a photocured pattern structure having a thickness of less than 1 mm. The composition comprising a polymer

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having at least one cinnamoyl group and a photoinitiator may be used in combination with an ethylenically unsaturated material.

A stabilizer may be added to the above-mentioned compositions to increase the storage stability of the compositions. Examples of the stabilizer will be mentioned later.

5 The term "ethylenically unsaturated material" used herein is intended to mean a prepolymer having at least one ethylenically unsaturated group (hereinafter often referred to as "ethylenically unsaturated prepolymer"), and an ethylenically unsaturated monomer.

The term "binder polymer" used herein is intended to mean a polymer compound which is not reactive with the ethylenically unsaturated compound.

10 The term "photoinitiator" used herein is intended to mean a compound which absorbs actinic rays to initiate or sensitize the photocuring reaction of a photocurable material in the resin composition to be used in the present invention.

When the photosensitive resin composition of the present invention is used for preparing a printing plate, from the viewpoints of high image-forming ability and high printing durability, a composition comprising an ethylenically unsaturated prepolymer, ethylenically unsaturated monomer and photoinitiator and a composition comprising a binder polymer, ethylenically unsaturated monomer and photoinitiator may preferably be used as the photocurable resin composition of the photosensitive resin composition.

With respect to the composition comprising an ethylenically unsaturated prepolymer, ethylenically unsaturated monomer and photoinitiator, an illustrative explanation will be given below.

As examples of the ethylenically unsaturated prepolymer, there may be mentioned unsaturated polyesters, ethylenically unsaturated prepolymer having at least one urethane bond such as unsaturated polyurethanes, unsaturated polyamides, unsaturated polyimides, unsaturated poly(meth)acrylates and various kinds of modified compounds thereof.

25 More specifically, as the unsaturated polyester, there may be mentioned unsaturated polyesters produced by the reaction of an unsaturated dibasic acid such as maleic acid, fumaric acid or itaconic acid or an acid anhydride thereof and a polyhydric alcohol such as ethylene glycol, propylene glycol, diethylene glycol, triethylene glycol, glycerin or trimethylolpropane; unsaturated polyesters produced by the reaction of three kinds of compounds, namely the above-mentioned unsaturated dibasic acid or acid anhydride thereof, a saturated polybasic acid such as succinic acid, adipic acid, phthalic acid, isophthalic acid, phthalic anhydride or trimellitic acid and the above-mentioned polyhydric alcohol; and unsaturated polyesters produced by the reaction of the above-mentioned unsaturated dibasic acid and a compound having two epoxy groups such as diglycidyl ether of bisphenol A. As the unsaturated polyurethane, there may be mentioned unsaturated polyurethanes produced by reacting a polyisocyanate with a polyol having at least 35 two terminal hydroxyl groups to obtain a polyurethane having terminal isocyanate groups or hydroxyl groups and then incorporating at least one addition polymerizable unsaturated group utilizing the reactivity of the terminal isocyanate groups of hydroxyl groups. In practicing the above-mentioned reaction, as the polyisocyanate, there may be used toluylene diisocyanate, diphenylmethane-4,4' - diisocyanate or hexamethylene diisocyanate and as the polyol, there may be used the above-mentioned polyhydric alcohol, a polyester polyol, a polyether polyol, 1,4-polybutadiene having terminal hydroxyl groups, 40 1,2-polybutadiene having terminal hydroxyl groups, hydrogenated 1,2-polybutadiene having terminal hydroxyl groups, a butadiene-styrene copolymer having terminal hydroxyl groups or a butadiene-acrylonitrile copolymer having terminal hydroxyl groups. After completion of the above-mentioned reaction, at least one addition polymerizable unsaturated group is introduced. The introduction of such an unsaturated group may be carried out by the reaction of an isocyanate with a compound having an active 45 hydrogen, namely a compound having a hydroxyl group, carboxyl group or amino group among the above-mentioned unsaturated carboxylic acids and esters thereof, and (meth)acrylic acids and esters thereof. The introduction of such an unsaturated group may also be carried out by the reaction of a hydroxyl group with a compound having a carboxyl group among the above-mentioned unsaturated 50 carboxylic acid and esters thereof, and (meth)acrylic acids and esters thereof. Further, as the unsaturated polyurethanes, there may be mentioned a compound produced by linking the above-mentioned polyester with a polyisocyanate.

The above-mentioned prepolymers are described in Japanese Patent Application Publications Nos. 51-37320, 52-7761, 52-36444, 52-7363 and 55-34930. Further, the prepolymers described in Japanese Patent 55 Application Laid-open Specification No. 56-120718 and Japanese Patent Application Publication No. 48-43126 may also be used in the present invention.

As the unsaturated polyamide to be used as the ethylenically unsaturated prepolymer, there may be mentioned unsaturated polyamides and N-substituted unsaturated polyamides. The unsaturated polyamides can be produced by the condensation polymerization of a diamine, an unsaturated dicarboxylic acid and a saturated dicarboxylic acid. As the diamine, there may be mentioned ethylenediamine, 60 hexamethylenediamine, dodecamethylenediamine, m-xylylenediamine, p-xylylenediamine and 1,4-bis(diaminomethyl) cyclohexane. As the unsaturated dicarboxylic acid, there may be mentioned maleic acid, fumaric acid and itaconic acid. As the saturated dicarboxylic acid, there may be mentioned succinic acid, adipic acid, phthalic acid, isophthalic acid, phthalic anhydride and trimellitic acid. The above- 65 mentioned N-substituted unsaturated polyamides which may also be used as the prepolymer can be

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produced by reacting, in the presence of a catalyst, allyl alcohol or β -methylallyl alcohol, formaldehyde and a polyamide. The polyamide to be used in this reaction can be produced by the condensation polymerization of cyclic caprolactams such as ϵ -caprolactam, ω -dodecanolactam and the like, the condensation polymerization of ω -amino acids or the condensation polymerization of the above-mentioned saturated dicarboxylic acid and the diamine.

As the unsaturated polymethacrylate to be used as the ethylenically unsaturated prepolymer, there may be mentioned unsaturated polymethacrylates which are produced by reacting methacrylic acid with the glycidyl group of a terpolymer of methyl methacrylate, acrylonitrile and glycidyl methacrylate or by the condensation reaction of the carboxyl group of a copolymer containing methacrylic acid with the hydroxyl group of hydroxyalkyl methacrylate.

As the unsaturated polyimide to be used as the ethylenically unsaturated prepolymer, there may be mentioned unsaturated polyimides which are produced by the condensation reaction of aromatic tetracarboxylic acid (such as pyromellitic acid or biphenyl - 4,4',5,5' - tetracarboxylic acid) with (meth)acrylamide-substituted diaminobenzene or (meth)acrylamide-substituted p,p'-diaminobiphenyl ether.

The number average molecular weight of the prepolymer to be used in the present invention is not critical but generally 500 or more. When a prepolymer has too high a number average molecular weight, the photosensitive resin composition containing such prepolymer is difficult to be dissolved or dispersed in a developer, so that a clear photocured pattern structure cannot be formed. Therefore, with respect to the upper limits of the number average molecular weight, the prepolymer to be used in the present invention has preferably such a number average molecular weight that the photosensitive resin composition containing the prepolymer is easily dissolved or dispersed in a developer.

Generally, when the number average molecular weight per double bond of the prepolymer is 1,000 or more, the surface tack of a photocured pattern structure is apt to become high. Especially, when the number average molecular weight per double bond of the prepolymer is 5,000 or more, the surface tack of a photocured pattern structure is considerably high. In the case of an unsaturated urethane prepolymer having at its both ends double bonds, the double bonds are in positions far distant from each other. In this case, the surface tack is further increased. The more the prepolymer is of such a kind as causes the photocured pattern structure to have a high surface tack, the more excellent the effect of the present invention. The upper limit of number average molecular weight per double bond of the prepolymer is almost the same as the number average molecular weight of the prepolymer.

The number average molecular weight of the prepolymer to be used in the present invention is generally determined by the gel permeation chromatography (GPC) or by calculation using the acid value of the prepolymer.

Generally known various kinds of ethylenically unsaturated monomers may be employed in the present invention. As the suitable ethylenically unsaturated monomer, there may be mentioned, for example, ethylenically unsaturated carboxylic acids such as acrylic acid and methacrylic acid; esters of such unsaturated carboxylic acids, such as alkyl (meth)acrylate, cycloalkyl (meth)acrylate, halogenated alkyl (meth)acrylate, alkoxyalkyl (meth)acrylate, hydroxyalkyl (meth)acrylate, aminoalkyl (meth)acrylate, tetrahydrofurfuryl (meth)acrylate, allyl (meth)acrylate, glycidyl (meth)acrylate, benzyl (meth)acrylate, phenoxy (meth)acrylate, alkylene glycol mono(meth)acrylate, alkylene glycol di(meth)acrylate, polyoxyalkylene glycol mono(meth)acrylate, polyoxyalkylene glycol di(meth)acrylate, trimethylolpropane tri(meth)acrylate and pentaerythritol tetra(meth)acrylate; acrylamide, methacrylamide and derivatives thereof such as N-alkyl(meth)acrylamide, N-hydroxyalkyl(meth)acrylamide, N,N-dialkyl(meth)acrylamide, N,N-dihydroxyalkyl(meth)acrylamide, diacetone (meth)acrylamide and N,N'-alkylenebis(meth)acrylamide; allyl compounds such as allyl alcohol, allyl isocyanate, diallyl phthalate and triallyl cyanurate; maleic acid, maleic anhydride, fumaric acid and esters thereof such as monoalkyl maleate or fumarate, dialkyl maleate or fumarate, mono(halogenated alkyl) maleate or fumarate, di(halogenated alkyl) maleate or fumarate, mono(alkoxyalkyl) maleate or fumarate and di(alkoxyalkyl) maleate or fumarate; and other ethylenically unsaturated compounds such as styrene, vinyltoluene, divinylbenzene, N-vinylcarbazole and N-vinylpyrrolidone. In combination with the above-mentioned ethylenically unsaturated monomer, an azide compound may be employed in the present invention.

The weight ratio of the above-mentioned monomer or the above-mentioned monomer plus the above-mentioned azide compound to the ethylenically unsaturated prepolymer may be 0/100 to 100/0, both exclusive.

Various known photoinitiators generally employed in photocure reactions may be incorporated into the photocurable resin composition in the present invention. As the suitable photoinitiator, there may be mentioned, for example, benzoin, benzoin alkyl ethers such as benzoin ethyl ether, benzoin n-propyl ether, benzoin isopropyl ether and benzoin isobutyl ether, and other compounds such as dimethoxyphenylacetophenone, benzophenone and thioxanthone.

The weight ratio of the photoinitiator to the ethylenically unsaturated prepolymer and the ethylenically unsaturated monomer is 0.001/100 to 10/100.

As the stabilizer to be used according to need, there may be mentioned, for example, hydroquinone, mono-tert-butyl hydroquinone, benzoquinone, 2,5 - diphenyl - p - benzoquinone, picric acid, di - p - fluorophenylamine, p - methoxyphenol, 2,6 - di - tert - butyl - p - cresol. The stabilizer to be used in the

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present invention may preferably be those which do not inhibit photochemical reaction but heat polymerization (or dark reaction) only. From the viewpoint of non-inhibition of the photochemical reaction, the weight ratio of the stabilizer to the ethylenically unsaturated prepolymer plus the ethylenically unsaturated monomer is 0.005/100 to 5.0/100.

5 With respect to the composition comprising a binder polymer, ethylenically unsaturated monomer and photoinitiator, an illustrative explanation will be given below.

As the binder polymer, there may be mentioned polyvinyl alcohol, polyamide and various kinds of rubber compounds. As examples of the ethylenically unsaturated monomer and the photoinitiator, the same examples as described above may be mentioned.

10 The weight ratio of the binder polymer to the ethylenically unsaturated monomer may be 99/1, inclusive to 0/100, exclusive. The weight ratio of the photoinitiator to the binder polymer plus ethylenically unsaturated monomer is 0.001/100 to 10/100.

A stabilizer of which the examples are mentioned above may also be incorporated in the composition at a weight ratio of the stabilizer to the binder polymer plus the ethylenically unsaturated monomer of 15 0.005/100 to 5.0/100.

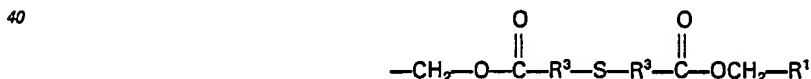
The number average molecular weight (as measured according to GPC) of the binder polymer to be used in the present invention is not critical but generally 20,000 or more. With respect to the upper limit of number average molecular weight of the binder polymer, the same explanation as described with respect to the prepolymer may apply.

20 The compound (I) to be employed in the present invention is represented by the formula



wherein R^1 stands for a monovalent hydrocarbon residue represented by C_nH_{2n+1} or C_nH_{2n-1} in which n is an integer of from 11 to 21; and X stands for $-COOH$, $-CONH_2$ or $-CH_2OR^2$ in which R^2 stands for H or $-CO-R^3-S-R^3-COOCH_2-R^4$ in which R^3 is a divalent hydrocarbon residue having 1 to 6 carbon atoms and R^4 has the same meaning as defined with respect to R^1 .

With respect to the compound (I) to be employed in the present invention, it is preferred that a suitable compound be selected according to the kind of the photocurable resin composition, taking into 30 consideration the solubility of the compound (I) in the composition and the effect of the addition amount of the compound (I) on the surface tack removal. A compound having a decreased number of carbon atoms tends to exhibit an increased solubility in the photocurable resin composition but a decreased surface tack removal effect. On the other hand, a compound having an increased number of carbon atoms tends to exhibit an increased surface tack removal effect but tends to cause the composition to cloud thereby to 35 decrease the image reproducibility of the composition. To attain an optimum solubility and surface tack removal effect, it is preferred that the number of carbon atoms of R^1 of the above formula be in the range of from 11 to 21. Especially, compounds of the formula (I) having a group X selected from the class consisting of a hydroxyl group, a carboxyl group, an amido group and a thiodiester group of the formula



wherein R^1 and R^3 are as defined above are preferred because of their capability of removing surface tack is 45 excellent. More especially, compounds of formula (I) wherein R^1 has 13 to 17 carbon atoms when X represents a hydroxyl group or a carboxyl group; R^1 is a saturated hydrocarbon residue having 13 carbon atoms or an ethylenically unsaturated hydrocarbon residue of the formula $C_{17}H_{33}$ when X represents an amido group; and R^1 has 11 to 17 carbon atoms and R^3 has 3 carbon atoms when X represents a thiodiester group can be advantageously utilized because they are excellent in surface tack removal effect and exhibit 50 a high solubility in the photocurable resin composition. The above-mentioned compounds of formula (I) may be used alone or in mixture.

Specific examples of the compound (I) are lauryl alcohol, myristyl alcohol, cetyl alcohol, stearyl alcohol, eicosyl alcohol, lauric acid, myristic acid, palmitic acid, stearic acid, eicosanic acid, lauramide, myristamide, palmitamide, stearamide, eicosanamide, dilauryl thiodipropionate, dimyristyl 55 thiodipropionate, distearyl thiodipropionate, oleyl alcohol, erucyl alcohol, oleic acid, erucic acid, oleamide, erucamide, tetradecenoic acid and behenic acid.

The compound (I) may be added to the photocurable resin composition alone or in combination. The amount of the compound (I) to be added in the present invention is not critical. The preferable weight ratio of the compound (I) to the photocurable resin composition varies according to the kind of the photocurable 60 resin composition because the solubility of the compound (I) in the photocurable resin composition varies depending on the kind of the composition. In general, however, it is noted that when the weight ratio of the compound (I) to the photocurable resin composition is 0.1/100 or more, the high surface tack-removing effect can be attained. On the other hand, when the weight ratio of the compound (I) to the photocurable resin composition is 6/100 or less, the resultant composition has an excellent clarity [the compound (I) is 65 dissolved in the photocurable resin composition], causing the image reproducibility of the composition to

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be high. Moreover, such a weight ratio of the compound (I) to the photocurable resin composition is advantageous because it causes the mechanical strength of the ultimate cured product to be high. Therefore, it is generally preferred that the weight ratio of the compound (I) to the photocurable resin composition be 0.1/100 to 6/100. Further, from the viewpoints of the surface tack removal effect and the mechanical strength of the ultimate cured product, it is especially preferred that the weight ratio of the compound (I) to the photocurable resin composition be 0.5/100 to 4/100.

The method of incorporating the compound (I) into the photocurable resin composition is not critical. That is, the compound (I) may be incorporated into the composition in various methods without any adverse effect on the advantage of the present invention. For example, in the case of the photocurable resin composition comprising an ethylenically unsaturated prepolymer, ethylenically unsaturated monomer and photoinitiator, the compound (I) may be incorporated into the composition by a method which includes first adding the compound (I) to the ethylenically unsaturated prepolymer to prepare a preliminary composition and subsequently blending the preliminary composition with the ethylenically unsaturated monomer, photoinitiator and any other employable component to prepare the intended composition; a method which includes first mixing the compound (I) with the ethylenically unsaturated monomer to prepare a preliminary composition and subsequently blending the preliminary composition with the ethylenically unsaturated prepolymer, photoinitiator and any other employable component to prepare the intended composition; or a method which includes blending the compound (I) with the photocurable resin composition consisting of the ethylenically unsaturated prepolymer, ethylenically unsaturated monomer, photoinitiator and any other materials to prepare the intended composition. The incorporation of the compound (I) into the photocurable resin composition may generally be performed at a temperature of about 40 to 100°C.

The compounds (I) as exemplified above are commercially available. Generally, the compound (I) can be easily synthesized as follows:

(i) In the case of $C_nH_{2n-1}X$ (unsaturated carboxylic acids, unsaturated amides and unsaturated alcohols):

A saturated carboxylic acid, for example, $C_{14}H_{28}COOH$ is reduced to $C_{14}H_{26}COH$ (aldehyde) according to the ordinary method. The obtained aldehyde is subjected to a condensation reaction with malonic acid (Knoevenagel reaction), followed by decarboxylation to prepare $C_{16}H_{31}COOH$ (unsaturated carboxylic acid). In this way, any desired unsaturated carboxylic acid having a predetermined number of carbon atoms can be obtained.

With respect to the unsaturated amides, according to the ordinary method, they can be easily derived from the carboxylic acids which are synthesized in the above manner.

With respect to the unsaturated alcohols, they can be synthesized by selectively reducing the above-obtained carboxylic acids using $LiAlH_4$ (lithium aluminum hydride).

(ii) In the case of $C_nH_{2n+1}X$ (saturated carboxylic acids, saturated amides and saturated alcohols):

When the unsaturated carboxylic acids which are obtained in the above-mentioned manner are hydrogenated in the presence of a catalyst, there can be obtained the desired saturated carboxylic acids.

With respect to the saturated amides and saturated alcohols, they can be synthesized in the same manner as described with respect to the case of $C_nH_{2n-1}X$.

(iii) In the case of thiodiesters:

A starting compound, R^5-S-R^5 (in which R^5 stands for a carboxylic acid residue having 2 to 7 carbon atoms) is reacted with an aliphatic alcohol to prepare a thiodiester according to the ordinary method. With respect to the starting compounds R^5-S-R^5 in which R^5 is a carboxylic acid residue having 2 to 3 carbon atoms, they are commercially available. With respect to the starting compounds R^5-S-R^5 in which R^5 is a carboxylic acid residue having 4 to 7 carbon atoms, they can be synthesized in the method disclosed in Acta Chim. Acad. Sci. Hung. 34, 87-91(1962).

The compounds (I) can also be synthesized according to other methods than the above-mentioned methods. For example, they can be prepared in the methods as disclosed in the following published literatures.

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In the case of $C_nH_{2n+1}-X$:

[Literature]

- | | | |
|----|--|--|
| 5 | (1) $n=12$
X=CH ₂ OH
X=COOH | Armstrong, M. D. et al, JACS, 65, 2252 (1943)
Organic Synth. 16, 35 (1936) |
| 10 | (2) $n=14$
X=CH ₂ OH
X=COOH | Ruhoff, J. R. et al, JACS, 55, 3825 (1933)
Wyrberg, H. et al, JACS, 78, 1958 (1956) |
| 15 | (3) $n=16$
X=CH ₂ OH
X=COOH | Watanabe A, Bull. Chem. Soc. Jpn., 32, 1295 (1954)
Buchta, E. et al, Justus Liebig's Ann. Chem., 698, 93 (1966) |
| 20 | (4) $n=18$
X=COOH
X=CH ₂ OH | Oskerk. A., Chem. Zentralbl., 2, 1264 (1914)
Levene, P. A., J. Biol. Chem., 59, 905 (1924) |

In the case of $C_nH_{2n-1}X$:

[Literature]

- | | | |
|----|--|---|
| 25 | (1) $n=14$
X=CH ₂ OH | Luning B. et al, Acta Chem. Scand 21, 829 (1967)
(14-pentadecene-1-ol) |
| 30 | (2) $n=9-16$
X=COOH, CH ₂ OH | "Zh. Org. Khim" 10(4), 696-700 (1974) |
| 35 | (3) $n=18$
X=COOH | Pierre Savary, Bull. Soc. Chim. France, pp. 624-627 (1950) |

($C_nH_{2n-1}CH_2OH$ can be prepared by reducing $C_nH_{2n-1}COOH$ using $AlLiH_4$.)

35 With respect to the above-mentioned compound (I), the amides thereof may be synthesized using the above compounds in the form of acid according to the ordinary method.

Pattern structures improved with respect to surface tack-free characteristic may be prepared by the various known methods using the photosensitive resin composition of the present invention. For example, first, the photosensitive resin composition of the present invention is applied to the surface of a substrate to form a photosensitive resin layer; second, the resin layer is image-wise exposed to actinic radiation through an image-bearing transparency such as a negative to convert the photosensitive resin layer to a layer having cured image portions and remaining uncured portions; third, the remaining uncured portions are removed to form a pattern structure of photocured resin. Then, post-exposure is performed to increase the mechanical strength.

45 The application of the photosensitive resin composition onto a substrate may be performed by various known methods such as a coating method using a doctor blade, an injecting method in which a spacer is provided between a metal base film and a glass substrate covered with a cover film to form a cavity and a photosensitive resin is injected into the cavity and a method in which a photosensitive resin composition is subjected to injection molding to form a photosensitive resin plate by means of an injection mold and then sandwiched between a protective film and a base film with an adhesive layer, followed by pressing by means of a roller. As the substrate, there may generally be employed films or plates having a thickness of 100-200 μ m such as polyester films, iron plates and aluminum plates. As the source of the actinic radiation there may be mentioned, for example, a carbon arc lamp, an ultra-high pressure mercury lamp, a high pressure mercury lamp, a low pressure mercury lamp, an ultraviolet fluorescent lamp, a metal halide lamp, a xenon lamp and the sun. The remaining uncured portions not irradiated with actinic radiation may be removed by blowing an air, or by the treatment with a liquid which is capable of dissolving or dispersing therein the uncured photosensitive resin. As such a liquid, there may be mentioned, for example, water; aqueous acid solutions such as aqueous acetic acid; aqueous alkaline solutions such as aqueous potassium hydroxide, aqueous sodium carbonate, aqueous sodium borate, aqueous sodium silicate, aqueous diethanolamine; aqueous solutions of surface active agent such as polyoxyethylene type surface active agent, aqueous alkylbenzene sulfonate, aqueous ADS, aqueous alkylammonium chloride; organic solvents such as 1,1,1-trichloroethane, methylene chloride, butoxyethanol, isopropyl alcohol.

The post-exposure may be performed in air or a liquid such as water.

65 The obtained pattern structure may be used as a decorative material after stripping the substrate or may be used, with the substrate remaining attached, as a letterpress, molding matrix, decorative material

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and the like. When the pattern structure is used as a letterpress, the substrate should have an adhesive layer.

The photosensitive resin composition of the present invention may preferably be used for preparing a printing plate for letterpress printing, especially for flexography.

In another aspect of the present invention, there is provided a method of preparing a surface-tack free photocured pattern structure which comprises:

- (i) applying to the surface of a substrate a photosensitive resin composition comprising
 - (a) an ethylenically unsaturated prepolymer having a number average molecular weight of 5000 or more per double bond;
 - (b) an ethylenically unsaturated monomer; and
 - (c) a photoinitiator;
 to form a photosensitive resin layer;
- (ii) image-wise exposing the photosensitive resin layer to actinic radiation through an image-bearing transparency to convert the photosensitive resin layer to a layer having cured image portions and remaining uncured portions;
- (iii) removing the remaining uncured portions to form a pattern structure of photocured resin; and
- (iv) subjecting the pattern structure to post-exposure to actinic radiation, with said pattern structure immersed in an aqueous solution containing an alkali metal salt or alkaline earth metal salt of sulfurous acid, which method is characterised in that to the photosensitive resin composition, as a further component,
- (d) at least one compound represented by the general formula (I)



wherein R^1 stands for a monovalent hydrocarbon residue represented by C_nH_{2n+1} or C_nH_{2n-1} in which n is an integer of from 11 to 21; and X stands for $-COOH$, $-CONH_2$ or $-CH_2OR^2$ in which R^2 stands for H or $-CO-R^3-S-R^3-COOCH_2-R^4$ in which R^3 is a divalent hydrocarbon residue having 1 to 6 carbon atoms and R^4 has the same meaning as defined with respect to R^1 , is admixed.

According to the above method, a photocured pattern structure which is free from surface tack can be stably obtained even immediately after the preparation thereof. Therefore, in case printing should be carried out using a photocured pattern structure (printing plate) immediately after the preparation thereof, the above method may be advantageously employed.

The application of the photosensitive resin composition, the exposure of the applied resin composition to actinic radiation and the removal of the remaining uncured portions (development) may be performed according to the various known methods which are illustratively mentioned above.

As the substrate, there may be employed various known substrates which are illustratively mentioned above.

As the alkali metal salt or alkaline earth metal salt of sulfurous acid to be used in the present invention, there may be mentioned, for example, sodium sulfite, potassium sulfate and calcium sulfite.

The alkali metal salt or alkaline earth metal salt of sulfurous acid may preferably be dissolved in water at a concentration of 0.01% by weight or more for post-exposure. When the concentration is 0.01% by weight or more, a high surface tack-removing effect can be attained immediately after the preparation of the pattern structure. The effect of the post-exposure on removal of the surface tack is affected by the kind and content of the compound (I) in the photosensitive resin composition. So, in order to stably obtain photocured products free from surface tack, the concentration of the alkali metal salt or alkaline earth metal salt of sulfurous acid is more preferably 0.05% by weight or more. The upper limit of the concentration is not critical. Even if the alkali metal salt or alkaline earth metal salt of sulfurous acid is added over the solubility to form a suspension, the removal of the surface tack can be attained by post-exposure using the suspension. The use of such suspensions, however, leads to a decrease in post-exposure efficiency. The post-exposure treatment is also intended to endow the products with other adequate properties and, for this purpose, sufficient radiation is required. Therefore, when a suspension of an alkali metal salt or alkaline earth metal salt is used for post-exposure, a prolonged operation time is required. Generally, the upper limit of the concentration of the alkali metal salt or alkaline earth metal salt of sulfurous acid may be determined taking into consideration the foregoing defects and cost. Practically, an aqueous solution containing an alkali metal salt or alkaline earth metal salt of sulfurous acid at a concentration up to a saturation concentration may be used.

The temperature of the aqueous solution containing the alkali metal salt or alkaline earth metal salt of sulfurous acid is not critical but may generally be in the range of from about 10 to 30°C.

As the source of post-exposure to be used in the present invention, there may be mentioned, for example, a carbon arc lamp, an ultra-high pressure mercury lamp, a pressure mercury lamp, an ultraviolet fluorescent lamp, a metal halide lamp, a xenon lamp, a germicidal lamp and sunlight.

The irradiation time and the irradiation intensity for post-exposure are the same as in the case of the ordinary post-exposure which is effected for endowing the products with adequate properties. Generally, the irradiation intensity is in the range of several hundreds to 1,000 mJ/cm². The irradiation time is, in the case of ultraviolet lamp, about 5 to 15 minutes.

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In the post-exposure, the distance between the surface of the pattern structure and the surface of an aqueous solution containing an alkali metal salt or alkaline earth metal salt of sulfurous acid is not critical and may be chosen according to the post-exposure conditions such as irradiation time and irradiation intensity.

5 After the post-exposure, drying may be effected in accordance with the ordinary method. In the present invention, for example, drying may be effected by blowing a heated air (about 60°C) for 10 to 15 minutes.

According to the present method of preparing a photocured pattern structure, there can be stably prepared a photocured pattern structure which is free from surface tack even immediately after the preparation thereof.

10 The improvement of the surface tack-free characteristic can be evaluated by the value of surface tack (in terms of g) which is determined according to the later-mentioned method. If the surface tack obtained according to the later-mentioned measurement is more than 50 g, troubles are caused. That is, if, for example in handling, such a product has once been placed on another product so that the tacky resin faces of both the products meet together, it becomes difficult to separate from each other. Moreover, if the products having a surface tack of more than 50 g have once been piled and stored, adhesion of the tacky surfaces of the relief images to the substrates such as various films, foils and plates is inevitably caused, so that the separation from each other also becomes difficult. Hence, it is desired that the photocured product have a surface tack as small as 50 g or less. When a photocured product having a high surface tack is employed as a printing plate, adhesion of paper dusts to the printing plate is caused, making the printed articles dirty. Moreover, when a material to be printed is paper, peeling of paper is caused by the adhesion of the printing plate to the paper. From the viewpoint of preventing these troubles, the surface tack of the photocured products for printing plates should be as small as possible, preferably 30 g or less.

From the usual photosensitive resin compositions, there are usually obtained photocured products having a surface tack of 100 g or more. While, from photosensitive resin compositions especially intended to give a low hardness, there are usually obtained photocured products having a surface tack as high as more than 300 g.

However, by the use of a photosensitive resin composition containing the compound (I), it has been realized to obtain photocured products having a surface tack as small as 30 g or less after several hours from the preparation thereof even by an ordinary photocuring method.

30 Moreover, when the post-exposure has been conducted using an aqueous solution containing an alkali metal salt or alkaline earth metal salt of sulfurous acid, the photocured products obtained from a photosensitive resin composition containing the compound (I) indicate no surface tack even just after the preparation thereof.

This invention will now be described in detail with reference to the following Examples and Comparative Examples in which all of "parts" are given on a weight basis unless otherwise indicated and which should not be construed to be limiting the scope of the present invention.

In the following Examples and Comparative Examples, the surface tack, tensile strength, tensile elongation and number average molecular weight of prepolymers were measured in accordance with the following methods.

40 (1) Measurement of surface tack:
A specimen was prepared as follows.

A negative having a transparent portion (10 cm×10 cm) was placed on a lower glass plate of APR exposure equipment AF 210E (trade name of an apparatus sold by Asahi Chemical Ind. Co., Ltd., Japan) and the negative was covered with a square-shaped cover film of CF 42 (trade name of a film manufactured and sold by Asahi Chemical Ind. Co., Ltd.). Two pairs of square-shaped spacers having a thickness of 3 mm were placed on the cover film so that the spacers of each pair are positioned in opposite relationship through a common square-shaped spacing (to become a cavity) formed therebetween, thereby to form a cavity. A photosensitive resin composition was poured to form a photosensitive resin layer and the layer was covered with BF 173 (trade name of a polyester film with an adhesive layer manufactured and sold by Asahi Chemical Ind. Co., Ltd., Japan). The polyester film was pressed with an upper glass plate. Then, exposure was effected for 30 seconds from the side of the polyester film and for 5 minutes from the side of the negative using Chemical Lamp FLR 20S · B-DU-37C/M (trade name of a chemical lamp manufactured and sold by Toshiba Corporation, Japan) having a central wavelength of 370 nm. Then, development, post exposure and drying were carried out according to the procedure described in each Example and Comparative Example to prepare a specimen having a thickness of 3 mm.

The surface tack of the specimen was measured at 20°C.

Turning now to the drawing, there is shown a schematic diagram of an apparatus for determining the surface tack of a photocured pattern structure. The specimen 1 thus prepared was attached to a level support 2 in such a manner that the resin face of the specimen was directed upward. An aluminum wheel 3 of 13 mm in width and 50 cm in diameter was brought into contact with the plane portion of the resin face of the specimen. A load of 500 g was applied to the aluminum wheel and allowed to stand for 4 seconds. Then, the wheel was lifted upward at a constant elevation speed of 30 mm/min until the specimen was separated from the wheel. The value of the stress just before the separation of the wheel 3 from the specimen 1 was measured using PICMA Tack Tester Model No. 235 (trade name of an apparatus

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manufactured and sold by Toyo Seiki Seisaku-sho, Ltd., Japan). The value of the surface tack is expressed in terms of the value of the stress as measured above.

(2) Measurement of tensile strength and tensile elongation:

- 5 A specimen was prepared as follows: Two pairs of square-shaped spacers having a thickness of 1 mm were arranged on a glass plate with a cover film so that the spacers of each pair are positioned in opposite relationship through a common square-shaped spacing (to become a cavity) formed therebetween, thereby to form a cavity. A photosensitive resin composition was charged in the cavity. Then, the cavity charged with the composition was covered with another glass plate with a cover film and the charged
10 composition was exposed for 10 minutes at an irradiation intensity of 1 mW/cm² from both the glass plate sides to actinic radiation emitted from Chemical Lamp FLR 20S · B-DU-37C/M (trade name of a chemical lamp manufactured and sold by Toshiba Corporation, Japan) having a central wavelength of 370 nm to obtain a photocured sheet. The obtained photocured sheet was die-cut to obtain a dumbbell specimen of 30 mm in distance between gages, 3 mm in width of parallel portion and 1 mm in thickness.
15 Using the above-obtained specimen, tensile strength and tensile elongation were determined in accordance with the method of JIS K-6301 (Japanese Industrial Standards K-6301).

(3) Number average molecular weight of prepolymers:

- The number average molecular weight of prepolymers was determined by the gel permeation
20 chromatography under the following condition unless otherwise indicated.

Column: Shodex 803+Shodex 804 (trade name of a column manufactured and sold by Showa Denko K.K., Japan)

Eluent: chloroform

Flow rate: 1 ml/min

- 25 Standard Material: polystyrene

Example 1

- One part of polypropylene glycol [number average molecular weight (hereinafter often referred to as " $\bar{M}_n=2,000$)] and one part of poly propylene glycol adipate diol ($\bar{M}_n=2,000$) were mixed with 0.2 part of
30 toluylene diisocyanate, and they were reacted at 80°C for 3 hours to obtain a polyurethane having at its both ends isocyanate groups. 2.2 Parts of the obtained polyurethane were reacted with 0.47 part of polypropylene glycol monomethacrylate ($\bar{M}_n=380$) at 80°C for 2 hours to obtain a modified polyurethane prepolymer having its both ends methacrylate groups ($\bar{M}_n=22,000$ [\bar{M}_n (calculated)=16,500]).

- 100 Parts of the thus obtained prepolymer were mixed with 25 parts of polypropylene glycol
35 monomethacrylate ($\bar{M}_n=380$), 15 parts of laurylmethacrylate, 10 parts of tetraethylene glycol dimethacrylate, 1.5 parts of 2,2-dimethoxy-2-phenyl acetophenone and 0.2 part of 2,6-di-tert-butyl-p-cresol to prepare a photocurable resin composition [Photocurable Resin Composition (a)]. To the Photocurable Resin Composition (a) were added 2 parts of myristic acid as Compound (I) and mixed at 50°C to prepare a photosensitive resin composition [Photosensitive Resin Composition (A)].

- 40 In the same manner as described before with respect to the measurement of surface tack, two pairs of square-shaped spacers polypropylene film as a cover film. The above Photosensitive Resin Composition (A) was poured into the cavity formed by the spacers and the polypropylene film. Then, the cavity filled with the Photosensitive Resin Composition (A) was covered with a 100 μ m-thick polyester film as a substrate to obtain a laminate sheet. The laminate sheet was exposed for 5 minutes from the side of the polypropylene
45 film as the cover film through a negative to actinic radiation emitted from Chemical Lamp FLR 20S · B—DU—37C/M (trade name of a chemical lamp manufactured and sold by Toshiba Corporation, Japan) having a central wavelength of 370 nm and placed at a distance of about 10 cm from the surface of the laminate sheet, followed by stripping the cover film. Then, the so obtained sheet was developed with an aqueous solution of a nonionic surface active agent [a 2 wt% aqueous solution of Wash Out Agent W-7
50 (trade name of a nonionic surface active agent sold by Asahi Chemical Ind. Co., Ltd., Japan) as a developer at 40°C, followed by the removal of the used developer with running water to prepare a relief-imaged plate. The thus obtained plate was immersed in water (25°C) with the relief-imaged side kept up so that the distance between the surface of the plate and the surface of the water was about 7 mm. Then, the plate in the water was exposed (post-exposure) for 15 minutes to actinic radiation emitted from the above-
55 mentioned chemical lamp placed at a distance of about 14 cm from the surface of the plate to obtain a photocured relief-imaged plate (photocured pattern structure). The obtained plate was dried in a current of heated air (60°C) for 15 minutes using Dryer & Postexposure Equipment Model AL-100P (trade name of an apparatus sold by Asahi Chemical Ind. Co., Ltd., Japan). After the thus obtained photocured relief-imaged plate was allowed to stand for 3 hours in the air of relative humidity of about 70% at 20°C, the surface tack
60 of the photocured relief-imaged plate was determined and found to be 0 (zero) g.

Example 2

- A liquid mixture composed of 43 parts of diethylene glycol, 14 parts of fumaric acid, 12 parts of itaconic
65 acid and 28 parts of adipic acid was subjected to esterification reaction at 220°C for 9 hours to obtain an unsaturated ester prepolymer having a number average molecular weight of 2,300 (determined by

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calculation using the acid value of the prepolymer). To 100 parts of the so obtained prepolymer were added 30 parts of 2-hydroxypropyl methacrylate, 2 parts of tetraethylene glycol dimethacrylate, 8 parts of a methacrylic acid diester of polypropylene glycol ($\bar{M}_n=400$), 4 parts of benzoin isopropyl ether and 0.2 part of 2,6-di-tert-butyl-p-cresol to prepare a photocurable resin composition [Photocurable Resin Composition (b)]. To the Photocurable Resin Composition (b) was added 4.2 parts of cetyl alcohol as Compound (I) and mixed at 50°C to prepare a photosensitive resin composition [Photosensitive Resin Composition (B)].

Substantially the same procedures as in Example 1 were repeated to prepare a relief-imaged plate except that the above-obtained Photosensitive Resin Composition (B) was used instead of Photosensitive Resin Composition (A) and that a 1 wt% aqueous sodium carbonate solution (40°C) was used as a developer instead of an aqueous solution of a nonionic surface active agent. The thus obtained plate was exposed for 10 minutes in air to the chemical lamp employed in Example 1 which was placed at a distance of about 5 cm from the surface of the plate to obtain a photocured relief-imaged plate. After the thus obtained photocured relief-imaged plate was allowed to stand for 3 hours in the air of relative humidity of about 70% at 20°C, the surface tack of the photocured relief-imaged plate was determined and found to be 0 g.

Example 3

300 Parts of a hydroxyl group-terminated hydrogenated 1,2-polybutadiene having 1.6 hydroxyl groups on the average in one molecule ($\bar{M}_n=3,000$; hydrogenation degree=95%) were mixed with 17.4 parts of toluylene diisocyanate, and they were reacted at 60°C for 3 hours with stirring. Then, a liquid mixture composed of 8.6 parts of 2-hydroxypropyl methacrylate, 0.1 part of hydroquinone and 0.1 part of dibutyltin dilaurate was added to the reaction mixture, and the reaction was conducted in a dry air atmosphere at 80°C until a characteristic absorption of MCO ($\lambda=\text{around } 2,260 \text{ cm}^{-1}$) was not substantially observed on an infrared absorption spectrum chart, to prepare a prepolymer having a number average molecular weight \bar{M}_n of 13,000 (calculated). To 100 parts of the so obtained prepolymer were added 40 parts of lauryl methacrylate, 10 parts of a methacrylic acid diester of polypropylene glycol having a number average molecular weight \bar{M}_n of 400, 3 parts of benzoin amyl ether, and 0.1 part of p-methoxy phenol to prepare a photocurable resin composition [Photocurable Resin Composition (c)]. To the Photocurable Resin Composition (c) was added 4.5 parts of palmitic acid as Compound (I) at 50°C to prepare a photosensitive resin composition [Photosensitive Resin Composition (C)].

Substantially the same procedures as in Example 1 were repeated to prepare a relief-imaged plate, except that the above-obtained Photosensitive Resin Composition (C) was used instead of Photosensitive Resin Composition (A). The thus obtained plate was immersed in water (25°C) and irradiated in the water from the relief-imaged side of the plate for 10 minutes with two kinds of actinic radiations, namely, actinic radiation emitted from the same chemical lamp as used in Example 1 and actinic radiation (central wavelength: 254 nm) emitted from Toshiba Germicidal Lamp GL-15 (trade name of a germicidal lamp manufactured and sold by Toshiba Corporation, Japan), both of which lamps were placed at a distance of about 15 cm from the relief surface of the plate. In that instance, the irradiation with the chemical lamp was effected simultaneously with the irradiation with the germicidal lamp, and the distance between the relief surface and the surface of the water was several millimeters to 10 millimeters. The thus obtained product was dried in a current of heated air (60°C) for 15 minutes using Dryer & Postexposure Equipment Model AL-100P (trade name of an apparatus sold by Asahi Chemical Ind. Co., Ltd., Japan) and then allowed to stand at 20°C for 3 hours to obtain a photocured relief-imaged plate. Then, the surface tack of the photocured relief-imaged plate was determined and found to be 20 g.

Comparative Example 1

Substantially the same procedures as in Example 1 were repeated to prepare a photocured relief-imaged plate, except that the addition of compound (I) (2 parts of myristic acid) to Photocurable Resin Composition (a) was omitted. The surface tack of the resulting photocured relief-imaged plate was as shown in Table 1 given below.

Comparative Example 2

Substantially the same procedures as in Example 2 were repeated to prepare a photocured relief-imaged plate, except that the addition of Compound (I) (4.2 parts of cetyl alcohol) to Photocurable Resin Composition (b) was omitted. The surface tack of the resulting photocured relief-imaged plate was as shown in Table 1 given below.

Comparative Example 3

Substantially the same procedures as in Example 3 were repeated to prepare a photocured relief-imaged plate, except that the addition of Compound (I) (4.5 parts of palmitic acid) to Photocurable Resin Composition (c) was omitted. The surface tack of the resulting photocured relief-imaged plate was as shown in Table 1 given below.

Examples 4 to 10

Substantially the same procedures as in Example 1 were repeated to prepare photocured relief-imaged

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plates, except that compounds as indicated in Table 1 given below were used as Compound (I) instead of 2 parts of myristic acid and that with respect to Example 6 the post-exposure was effected in the same manner as in Example 3. The surface tacks of the resulting photocured relief-imaged plates were as shown in Table 1 given below.

TABLE 1

	Photosensitive resin composition				Surface tack of photocured relief-imaged plate (g)
	Photo-curable resin composition		Compound (I)		
	Kind	Amount (parts)	Kind	Amount (parts)	
Comparative Example 1	(a)	100	None	0	500
Example 2	(b)	100	„	0	150
Example 3	(c)	100	„	0	400
Example 4	(a)	100	Dimyristyl thio-dipropionate	3	0
Example 5	(a)	100	Oleic amide	1	0
			Dilauryl thio-dipropionate	0.5	
Example 6	(a)	100	Erucic amide	1.5	10
Example 7	(a)	100	Dilauryl thio-dipropionate	1.8	0
Example 8	(a)	100	Palmitic acid amide	3	0
Example 9	(a)	100	Stearic acid amide	1.5	0
Example 10	(a)	100	Eicosanic acid	3	10

Examples 11 to 16

Substantially the same procedures as in Example 1 were repeated to prepare photocured relief-imaged plates, except that the compounds as shown in Table 2 were used as Compound (I) in an amount as shown in Table 2 instead of 2 parts of myristic acid. The surface tacks of the photocured relief-imaged plates thus obtained were determined and the results are shown in Table 2.

TABLE 2

Example	Compound (l)		Clarity of photosensitive resin composition (at 20°C)	Photocured relief-imaged plate		
	Kind	Amount (part)*		Tensile strength (Kg/cm ²)	Tensile elongation (%)	Surface tack (g)
Example 11	Cetyl alcohol	2	Excellent	100	340	30
Example 12	"	4	"	70	200	0
Example 13	Dimyristyl thiodipropionate	0.5	"	110	330	30
Example 14	"	1.0	"	100	330	0
Example 15	"	3.0	"	80	220	0
Example 16	Myristic acid	6.0	"	80	250	0

Note: * Amount (part) based on 100 parts of Photopolymerizable Resin Composition (a).

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Example 17

Substantially the same procedures as in Example 1 were repeated to prepare a photocured relief-imaged plate, except that the post-exposure was effected in a 0.1 wt% aqueous solution of sodium sulfite instead of water. The resulting photocured relief-imaged plate was dried in a current of heated air (60°C) for 15 minutes using Dryer & Postexposure Equipment Model AL-100P (trade name of an apparatus sold by Asahi Chemical Ind. Co., Ltd., Japan). Immediately after completion of the drying, the surface tack of the photocured relief-imaged plate was determined and found to be 0 (zero) g.

Example 18

Substantially the same procedures as in Example 17 were repeated to prepare a photocured relief-imaged plate, except that erucic amide was used as Compound (I) instead of myristic acid. Immediately after completion of the drying (60°C, 15 minutes), the surface tack of the photocured relief-imaged plate was determined and found to be 0 (zero) g.

Examples 19 to 24

Six relief-imaged plates were prepared in the same manner as in Example 1. The thus prepared relief-imaged plates were immersed in aqueous solutions of sodium sulfite having various concentrations shown in Table 3 given below. Toshiba Chemical Lamp FLR 20S - B—DU—37 c/M (trade name of a chemical lamp manufactured and sold by Toshiba Corporation, Japan) and Toshiba Germicidal Lamp GL-15 (trade name of a germicidal lamp manufactured and sold by Toshiba Corporation, Japan) were each placed at a distance of about 15 cm from the relief surfaces of the relief-imaged plates. The relief-imaged plates were irradiated in the aqueous sodium sulfites from the relief sides for about 10 minutes with two kinds of actinic radiation (central wavelength: chemical lamp, 370 nm; germicidal lamp, 254 nm) emitted from the above-mentioned two lamps. In that instance, the irradiation with the chemical lamp was effected simultaneously with the irradiation with the germicidal lamp, and the distance between the relief surfaces and the surfaces of the aqueous sodium sulfites were each several millimeters to 10 millimeters. The thus obtained products were dried in a current of heated air (60°C) for 15 minutes using Dryer & Postexposure Equipment Model AL-100P (trade name of an apparatus sold by Asahi Chemical Ind. Co., Ltd., Japan) and then allowed to stand at room temperature for 30 minutes to obtain photocured relief-imaged plates. The surface tacks of the photocured relief-imaged plates were determined. The results are shown in Table 3 given below.

TABLE 3

Example No.	Concentration of aqueous sodium sulfite used in post-exposure (wt%)	Surface tack of photocured relief-imaged plate (g)
19	0 (water)	50
20	0.005	35
21	0.01	20
22	0.05	6
23	0.1	0
24	0.5	0

Comparative Example 4

Substantially the same procedures as in Comparative Example 1 were repeated to prepare a photocured relief-imaged plate, except that the post-exposure was effected in a 0.1 wt% aqueous sodium sulfite instead of water. The surface tack of the photocured relief-imaged plate thus obtained was determined. The results obtained are shown in Table 4 given below. For comparison, the data with respect to the photocured relief-imaged plates obtained in Examples 1 and 17 and Comparative Example 1 are also shown in Table 4.

TABLE 4

Example	Photosensitive resin composition		Solution used in post-exposure	Surface tack of photocured relief-imaged plate (g)	
	Photocurable resin composition	Compound (I) (Amount: parts)		Immediately after drying ^{*1}	After 3 hours ^{*2}
Example 17	(a)	Myristic acid (2)	0.1 wt% aqueous sodium sulfite	0	0
Comparative Example 4	(a)	None	"	500	500
Example 1	(a)	Myristic acid (2)	Water	50	0
Comparative Example 1	(a)	None	"	500	500

Note:

^{*1} Immediately after the resulting photocured relief-imaged plate was dried at 60°C for 15 minutes.^{*2} After the resulting photocured relief-imaged plate was dried at 60°C for 15 minutes and then allowed to stand at room temperature for 3 hours.

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Examples 25 to 28

Substantially the same procedures as in Example 17 were repeated to prepare photocured relief-imaged plates, except that the post-exposure was effected in various aqueous solutions shown in Table 5 instead of 0.1 wt% aqueous sodium sulfite. The surface tacks of the resulting photocured relief-imaged plates were determined. The results are shown in Table 5.

TABLE 5

Example No.	Solution * ¹ used in post-exposure	Surface tack of photocured relief-imaged plate (g)	
		Immediately after drying* ²	After 3 hours* ³
Example 25	Sodium thiosulfate	113	10
Example 26	Grape sugar	40	0
Example 27	Potassium sulfite	0	0
Example 28	Calcium sulfite	0	0

Note:

*¹ 1 wt% aqueous solution

*² Immediately after the resulting photocured relief-imaged plate was dried at 60°C for 15 minutes.

*³ After the resulting photocured relief-imaged plate was dried at 60°C for 15 minutes and then allowed to stand at room temperature for 3 hours.

Claims

1. A photosensitive resin composition to be used for preparing a printing plate for flexography which is improved with respect to surface tack-free characteristic after curing by exposure to actinic radiation, said photosensitive resin composition comprising:

a) an ethylenically unsaturated prepolymer having a number average molecular weight of 5000 or more per double bond;

b) an ethylenically unsaturated monomer; and

c) a photoinitiator, characterized in that it further comprises:

d) at least one compound represented by the general formula (I)



wherein R¹ stands for a monovalent hydrocarbon residue represented by C_nH_{2n+1} or C_nH_{2n-1} in which n is an integer of from 11 to 21; and X stands for —COOH, —CONH₂ or —CH₂OR² in which R² stands for H or —CO—R³—S—R³—COOCH₂—R⁴ in which R³ is a divalent hydrocarbon residue having 1 to 6 carbon atoms and R⁴ has the same meaning as defined with respect to R¹.

2. A photosensitive resin composition according to claim 1, which further comprises a binder polymer.

3. A photosensitive resin composition according to any one of claims 1 and 2, wherein said ethylenically unsaturated prepolymer has at least one urethane bond.

4. A photosensitive resin composition according to any one of claims 1 and 2, wherein said ethylenically unsaturated prepolymer is an ethylenically unsaturated polyester.

5. A photosensitive resin composition according to any one of claims 1 and 2, wherein said ethylenically unsaturated prepolymer is an unsaturated polyurethane (meth)acrylate.

6. A photosensitive resin composition according to claim 1, wherein said compound (d) is a saturated or unsaturated aliphatic carboxylic acid having 14 to 18 carbon atoms.

7. A photosensitive resin composition according to claim 1, wherein said compound (d) is a saturated or unsaturated aliphatic alcohol having 14 to 18 carbon atoms.

8. A photosensitive resin composition according to claim 1, wherein said compound (d) is palmitic acid amide or oleic amide.

9. A photosensitive resin composition according to claim 1, wherein said compound (d) is dimyristyl thiodipropionate or dilauryl thiodipropionate.

10. A photosensitive resin composition according to claim 1, wherein the weight ratio of said compound (d) to the photocurable resin composition is 0.1/100 to 6/100.

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11. A method of preparing a surface-tack free photocured pattern structure which comprises:
- (i) applying to the surface of a substrate a photosensitive resin composition comprising:
- (a) an ethylenically unsaturated prepolymer having a number average molecular weight of 5000 or more per double bond;
- 5 (b) an ethylenically unsaturated monomer; and
- (c) a photoinitiator; to form a photosensitive resin layer;
- (ii) image-wise exposing the photosensitive resin layer to actinic radiation through an image-bearing transparency to convert the photosensitive resin layer to a layer having cured image portions and remaining uncured portions;
- 10 (iii) removing the remaining uncured portions to form a pattern structure of photocured resin; and
- (iv) subjecting the pattern structure to post-exposure to actinic radiation, with said pattern structure immersed in an aqueous solution containing an alkali metal salt or alkaline earth metal salt of sulfurous acid, which method is characterised in that the photosensitive resin composition comprises, as a further component.
- 15 d) at least one compound represented by the general formula (I)



wherein R^1 stands for a monovalent hydrocarbon residue represented by C_nH_{2n+1} or C_nH_{2n-1} in which n is an integer of from 11 to 21; and X stands for $-COOH$, $-CONH_2$ or $-CH_2OR^2$ in which R^2 stands for H or $-CO-R^3-S-R^3-COOCH_2-R^4$ in which R^3 is a divalent hydrocarbon residue having 1 to 6 carbon atoms and R^4 has the same meaning as defined with respect to R^1 .

12. A method according to claim 11, wherein said alkali metal salt of sulfurous acid is sodium sulfite.
13. A method according to claim 11, wherein said aqueous solution contains an alkali metal salt or alkaline earth metal salt of sulfurous acid at a concentration of 0.01% by weight or more.

Patentansprüche

1. Lichtempfindliche Kunstharz-Zusammensetzung zur Verwendung in der Herstellung einer Druckplatte für die Flexographie, die nach Härten durch Bestrahlung mit aktinischer Strahlung hinsichtlich klebefreien Oberflächen-Eigenschaften verbessert ist, wobei die lichtempfindliche Kunstharz-Zusammensetzung folgende Komponenten umfaßt:
- (a) ein ethylenisch ungesättigtes Prepolymer mit einem Zahlenmittel des Molekulargewichts von 5000 oder mehr pro Doppelbindung;
- 35 (b) ein ethylenisch ungesättigtes Monomer und
- (c) einen Photoinitiator, dadurch gekennzeichnet, daß sie außerdem umfaßt
- (d) wenigstens eine Verbindung der allgemeinen Formel (I)



40 worin R^1 für einen einwertigen Kohlenwasserstoff-Rest der Formeln C_nH_{2n+1} oder C_nH_{2n-1} steht, worin n eine ganze Zahl von 11 bis 21 ist; und X für $-COOH$, $-CONH_2$ oder $-CH_2OR^2$ steht, worin R^2 für H oder $-CO-R^3-S-R^3-COOCH_2-R^4$, worin R^3 ein zweiwertiger Kohlenwasserstoff-Rest mit 1 bis 6 Kohlenstoff-Atomen ist und R^4 dieselbe Bedeutung hat, wie sie für R^1 definiert wurde.

- 45 2. Lichtempfindliche Kunstharz-Zusammensetzung nach Anspruch 1, die außerdem ein Binder-Polymer umfaßt.

3. Lichtempfindliche Kunstharz-Zusammensetzung nach einem der Ansprüche 1 und 2, worin das ethylenisch ungesättigte Prepolymer wenigstens eine Urethan-Bindung hat.

4. Lichtempfindliche Kunstharz-Zusammensetzung nach einem der Ansprüche 1 und 2, worin das ethylenisch ungesättigte Prepolymer ein ethylenisch ungesättigter Polyester ist.
- 50 5. Lichtempfindliche Kunstharz-Zusammensetzung nach einem der Ansprüche 1 und 2, worin das ethylenisch ungesättigte Prepolymer ein ungesättigtes Polyurethan-(meth)acrylat ist.

6. Lichtempfindliche Kunstharz-Zusammensetzung nach Anspruch 1, worin die Komponente (d) eine gesättigte oder ungesättigte aliphatische Carbonsäure mit 14 bis 18 Kohlenstoff-Atomen ist.

55 7. Lichtempfindliche Kunstharz-Zusammensetzung nach Anspruch 1, worin die Komponente (d) ein gesättigter oder ungesättigter aliphatischer Alkohol mit 14 bis 18 Kohlenstoff-Atomen ist.

8. Lichtempfindliche Kunstharz-Zusammensetzung nach Anspruch 1, worin die Komponente (d) Palmitinsäureamid oder Ölsäureamid ist.

9. Lichtempfindliche Kunstharz-Zusammensetzung nach Anspruch 1, worin die Komponente (d)

- 60 Dimyristylthiodipropionat oder Dilaurylthiodipropionat ist.
10. Lichtempfindliche Kunstharz-Zusammensetzung nach Anspruch 1, worin das Gewichtsverhältnis der Komponente (d) zur Licht-härtbaren Kunstharz-Zusammensetzung 0,1/100 bis 6/100 ist.

11. Verfahren zur Herstellung einer an der Oberfläche klebefreien Struktur eines lichtgehärteten Musters, das folgende Schritte umfaßt:

65 (i) Aufbringen einer lichtempfindlichen Kunstharz-Zusammensetzung aus

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- (a) einem ethylenisch ungesättigten Prepolymer mit einem Zahlenmittel des Molekulargewichts von 5000 oder darüber pro Doppelbindung;
 (b) einem ethylenisch ungesättigten Monomer, und
 (c) einem Photoinitiator, auf die Oberfläche eines Substrats unter Bildung einer lichtempfindlichen
- 5 Kunstharz-Schicht;
 (ii) Bild-weises Bestrahlen der lichtempfindlichen Kunstharzschicht mit aktinischer Strahlung durch ein ein Bild tragendes Transparentbild unter Umwandlung der lichtempfindlichen Kunstharz-Schicht in eine Schicht mit gehärteten Bild-Teilen und übrigen ungehärteten Teilen;
 (iii) Entfernen der übrigen ungehärteten Teile unter Bildung einer gemusterten Struktur eines
- 10 lichtgehärteten Kunstharzes und
 (iv) Nachbestrahlen der gemusterten Struktur mit aktinischer Strahlung, wobei die gemusterte Struktur in eine wässrige Lösung eingetaucht ist, die ein Alkalimetallsalz oder ein Erdalkalimetallsalz der schwefligen Säure enthält, wobei das Verfahren dadurch gekennzeichnet ist, daß die lichtempfindliche Kunstharz-Zusammensetzung als weiteren Bestandteil
- 15 (d) wenigstens eine Verbindung der allgemeinen Formel (I) umfaßt



worin R^1 für einen einwertigen Kohlenwasserstoff-Rest der Formeln C_nH_{2n+1} oder C_nH_{2n-1} steht, worin n eine ganze Zahl von 11 bis 21 ist; und X für $-\text{COOH}$, $-\text{CONH}_2$ oder $-\text{CH}_2\text{OR}^2$ steht, worin R^2 für H oder $-\text{CO}-\text{R}^3-\text{S}-\text{R}^3-\text{COOCH}_2-\text{R}^4$, worin R^3 ein zweiwertiger Kohlenwasserstoff-Rest mit 1 bis 6 Kohlenstoff-Atomen ist und R^4 dieselbe Bedeutung hat, wie sie für R^1 definiert wurde.

12. Verfahren nach Anspruch 11, worin das Alkalimetallsalz der schwefligen Säure Natriumsulfit ist.
 13. Verfahren nach Anspruch 11, worin die wässrige Lösung ein Alkalimetallsalz oder
 25 Erdalkalimetallsalz der schwefligen Säure in einer Konzentration von 0,01 Gew.-% oder darüber enthält.

Revendications

1. Composition de résine photosensible, destinée à être utilisée pour préparer une plaque d'impression
 30 flexographique, qui est améliorée pour ce qui concerne la caractéristique de surface non collante après durcissement par exposition à un rayonnement actinique, cette composition photosensible de résine comprenant:
- a) un prépolymère à insaturation éthylénique ayant une masse moléculaire moyenne en nombre de 5000 ou supérieure à 5000 par double liaison;
 35 b) un monomère à insaturation éthylénique;
 c) un photoinitiateur, caractérisée en ce qu'elle comprend, en outre,
 d) au moins un composé de formule générale (I)



40 dans laquelle R^1 est un radical hydrocarboné monovalent, représenté par C_nH_{2n+1} ou C_nH_{2n-1} dans lesquelles n est un nombre entier de 11 à 21; et X est $-\text{COOH}$, $-\text{CONH}_2$ ou $-\text{CH}_2\text{OR}^2$ dans laquelle R^2 est H ou $-\text{CO}-\text{R}^3-\text{S}-\text{R}^3-\text{COOCH}_2-\text{R}^4$ dans laquelle R^3 est un radical hydrocarboné divalent ayant de 1 à 6 atomes de carbone et R^4 a la même définition que celle donnée pour R^1 .

45 2. Composition photosensible de résine suivant la revendication 1, qui comprend en outre un polymère servant de liant.

3. Composition photosensible de résine suivant l'une quelconque des revendications 1 et 2, dans laquelle le prépolymère à insaturation éthylénique a au moins une liaison d'uréthane.

4. Composition photosensible de résine suivant l'une quelconque des revendications 1 et 2, dans
 50 laquelle le prépolymère à insaturation éthylénique est un polyester à insaturation éthylénique.

5. Composition photosensible de résine suivant l'une quelconque des revendications 1 et 2, dans laquelle le prépolymère à insaturation éthylénique est un polyuréthane (méth)acrylate insaturé.

6. Composition photosensible de résine suivant la revendication 1, dans laquelle le composé (d) est un acide carboxylique aliphatique saturé ou insaturé ayant de 14 à 18 atomes de carbone.

55 7. Composition photosensible de résine suivant la revendication 1, dans laquelle le composé (d) est un alcool aliphatique saturé ou insaturé ayant de 14 à 18 atomes de carbone.

8. Composition photosensible de résine suivant la revendication 1, dans laquelle le composé (d) est l'amide de l'acide palmitique ou l'amide oléique.

9. Composition photosensible de résine suivant la revendication 1, dans laquelle le composé (d) est le
 60 thiodipropionate de dimyristyle ou le thiodipropionate de dilauryle.

10. Composition photosensible de résine suivant la revendication 1, dans laquelle le rapport pondéral du composé (d) à la composition photodurcissable de résine est compris entre 0,1/100 et 6/100.

11. Procédé de préparation d'une structure à motifs photodurcie et non collante en surface qui
 consiste:

- 65 (i) à appliquer à la surface d'un substrat une composition photosensible de résine comprenant

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- (a) un copolymère à insaturation éthylénique ayant une masse moléculaire moyenne en nombre de 5000 ou supérieure à 5000 par double liaison;
- (b) un monomère à insaturation éthylénique; et
- (c) un photoinitiateur;
- 5 pour former une couche photosensible de résine;
- (ii) à exposer de manière à former une image la couche photosensible de résine à un rayonnement actinique à travers une dispositif portant une image pour transformer la couche photosensible de résine en une couche ayant des parties durcies portant une image et des parties restantes non durcies;
- (iii) à enlever les parties restantes non durcies pour former une structure à motifs en résine
- 10 photodurcie;
- (iv) à soumettre la structure à motifs à une postexposition et à un rayonnement actinique, cette structure à motifs étant immergée dans une solution aqueuse contenant un sel de métal alcalin ou un sel de métal alcalino-terreux de l'acide sulfureux,
- ce procédé étant caractérisé en ce que la composition photosensible de résine comprend, comme
- 15 autres constituants
- (d) au moins un composé de formule générale (I)

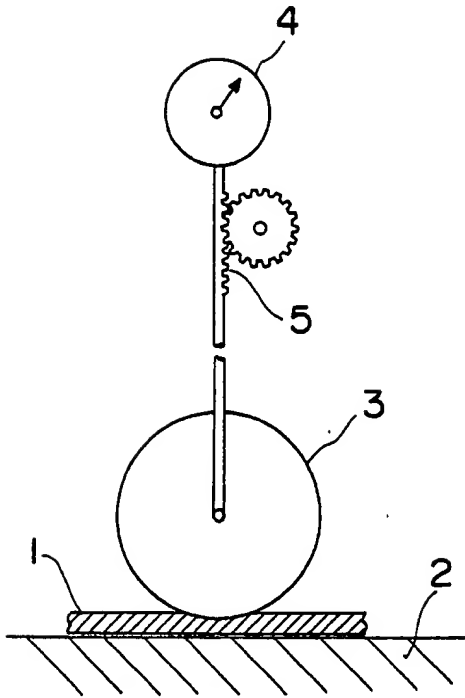


(I)

- 20 dans laquelle R^1 est un radical hydrocarboné monovalent, représenté par C_nH_{2n+1} ou C_nH_{2n-1} dans lesquelles n est un nombre entier de 11 à 21; et X est $-COOH$, $-CONH_2$ ou $-CH_2OR^2$ dans laquelle R^2 est H ou $-CO-R^3-S-R^3-COOH-R^4$ dans laquelle R^3 est un radical hydrocarboné divalent ayant de 1 à 6 atomes de carbone et R^4 a la même définition que celle donnée pour R^1 .

- 25 12. Procédé suivant la revendication 1, dans lequel le sel de métal alcalin de l'acide sulfureux est le sulfite de sodium.

13. Procédé suivant la revendication 11, dans lequel la solution aqueuse contient un sel de métal alcalin ou un sel de métal alcalino-terreux de l'acide sulfureux en une concentration de 0,01 % en poids ou en une concentration supérieure à cette valeur.



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